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LEADS AND QUALITY ENLISTMENTS: THE RELATIVE IMPACTS OF  
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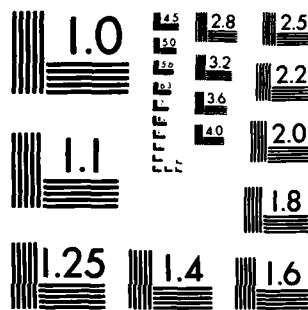
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### LEADS AND QUALITY ENLISTMENTS:

The Relative Impacts of Joint and Navy Specific Advertising  
on Production of Upper Mental, HSDG, Male, Navy Enlistments

Contract N00014-80-C-0200

Report ONR-200-9

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March, 1983

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## 1.0 BACKGROUND

The Navy Recruiting Command collects data on three distinct types of leads for enlistment personnel:

### i) NOIC - Navy Originated Leads

These represent unduplicated responses to the Navy's service specific national advertising and excludes those NOIC leads that originate from DOD's Joint Advertising (JADOR campaign). In FY80, FY81, and FY82, this type of lead totaled respectively 69,709, 136,832, and 141,753, involving a total placement cost of about \$4.418 million in FY80 and \$6.54 million for FY81.\* The FY80 and FY81 Navy national advertising campaigns were broken down in the following manner: \$3.388 million for TV/Radio in FY80 (the corresponding number was \$110 thousand for FY81); \$.431 million for Direct Mail for FY80 versus \$.258 million for FY81; and \$.562 million for the Minority Campaign in FY80 versus \$.69 million in FY81. When an estimated overhead rate of 26% is added in, the average cost per NOIC - Navy originated lead was about \$67 in FY80 and \$60 in FY81.

### ii) NOIC - JADOR Originated Leads

These represent unduplicated inquiries to the Navy, originated from the JADOR campaign. In FY80, these totaled 76,756 NOIC leads involving a total placement cost of \$7.793 million. The corresponding quantity for FY81 was 85,911 and a cost of about \$8 million. The number of NOIC - JADOR leads in FY82 was 71,499. The JADOR advertising budget in FY80 was distributed in the following way: \$3.364 million for TV; \$.926 million for JADOR Radio; \$2.167 million for JADOR Magazines; \$.967 million for JADOR Direct Mail and \$.359 million for JADOR supplements. For FY81, it was distributed at \$3.207M for TV, \$2.073M for Radio, \$.481M for Magazines, and \$1.607M for supplements. About \$3M was targeted to selected areas for an educational assistance test.

The JADOR advertising of course produces leads for the other three Services as well and so comparison of the cost per NOIC lead from the two sources is not very insightful. Given this caveat, when one computes the average cost per NOIC

\* The advertising costs for FY82 have not yet been analyzed.

(JADOR originated) lead, applying the same 26% overhead factor as was the case for the Navy specific advertising, this cost is about \$128 for FY80 and \$119 for FY81.

iii) Local Leads

These were collected for the first time in FY80, and represent exclusively leads from the Navy LAMS Program (i.e., classified ads in local newspapers and in high school newspapers). The placement cost for LAMS in FY82 totaled \$1.404 million and generated a reported total of 90,624 qualified, interested local leads. If we add in an estimated overhead factor of 38%, we obtain an estimate on the cost per local lead of about \$15. The corresponding figures for FY81 were 61,477 local leads at a LAMS cost of \$1.414M, or an average burdened cost of about \$32 per lead.

The optimal mix of these three types of leads as well as the proportion of the Budget that should be devoted to recruiter expenditures depends upon the relative success and cost of each of these resources. To help gain some quantitative insights into this aspect, four non-linear regression equations were estimated, using monthly-district data, to take advantage of both time series and cross sectional variation:

- i) the separate prediction of each of the above three types of leads as a function of demographics, seasonal variables and various levels of advertising;
- ii) the prediction of the number of quality contracts obtained as a function of demographics, seasonal variables, recruits, and the numbers of the three types of leads obtained. The focus on the quality contracts is due to the fact that regression estimation techniques are only appropriate for the truly supply limited category of recruits. The measure of quality used is whether or not the recruit is an Upper Mental High School Degree Graduate (HSDG); i.e., those scoring in the renormed Mental categories of 1-III A, and excludes those with GED's).

The usefulness of the above equations are to explore the respective yield rates, in terms of male, non-prior service, Upper Mental HSDG contracts, from various types of leads and to discern the best mix of advertising for each type of lead. Also, the use of monthly data enables us to estimate advertising lag times (i.e., how long does it take for the advertising to make itself felt) as well as the time periods involved in transforming leads into contracts.

The caveat that should be mentioned is that none of the other Services' advertising levels are included. This is because at the district-monthly level analyzed, while the Navy and JADOR advertising levels are known for each media type, the other Services advertising levels are not. Hence any competitive effects, "market leader" phenomenon, and any other cross service synergistic effects could not be captured.

Before getting into the econometric results, the following comparison of resources consumed and performance related outputs for FY80, FY81 and FY82 should be of interest: (see Table 1).

## 2.0 ECONOMETRIC ANALYSES FOR DIFFERENT CATEGORIES OF LEADS

### 2.1 Results for NOIC - Navy Originated Leads

Consider the results for NOIC - Navy originated leads first, the portion of the NOIC leads that the Navy can really influence. The estimation approach utilizes a so called log-log regression which results in the estimated regression parameters being interpreted as elasticities, e.g., the elasticity of a given resource on NOIC leads is the percentage increase in NOIC leads that would have been expected if a 1% increase in the resource had occurred, everything else being held constant. This model has the important features that it can capture the diminishing return nature of recruiting resources, and has been validated in terms of its predictive ability (see [4]). The estimation procedure utilized is a powerful one known as the Park's Method (see [1]) and is well suited to pooled time series, cross sectional data

TABLE 1  
COMPARISON OF FY80'S, FY81'S, AND FY82'S KEY RESOURCES AND OUTCOMES

	<u>FY80</u>	<u>FY81</u>
1) Number of Male, High School Seniors	1,620,012	1,624,936
2) Number of Male, Upper Mental High School Seniors		789,769
3) Average Local Unemployment Rate Over All Districts	6.35%	6.98% ** (8.8%)
4) Average Percent of Male 17-21 Year Olds that are Black (Over all Districts)	.149	.145
5) LAMS Expenditures * (Local Advertising)	\$1.207M	\$1.404M ** (\$1.325M)
6) Number of Qualified Interested Local Leads Reported	55,645	61,477 ** (90,624)
7) GEP - General TV/Radio Expenditures *	\$3.388M	\$5.434M
8) GEP - General Magazines Expenditures *	\$38K	\$1.148M
9) GEP - General Direct Mail Expenditures *	\$430K	\$.856M
10) JADOR TV/Radio Expenditures *	\$4.291M	\$15.272M
11) JADOR Magazines Expenditures *	\$2.526M	\$11.910M
12) JADOR Direct Mail Expenditures *	\$967K	\$.215M
13) JADOR Supplement Expenditures *	\$359K	\$1.607M
14) # of Recruiter Man Years	3,752.1	3,793.4 ** (3,641.4)
15) # of NOIC Navy Originated Leads	69,709	136,832 ** (141,753)
16) # of NOIC JADOR Originated Leads	76,756	85,911 ** (71,499)
17) # of HSDG Male Contracts	63,929	60,741
18) # of Upper Mental, HSDG Male Contracts	36,680	37,928 **

\* Placement Costs

\*\* Level in FY82



in that it relaxes many of the stringent assumptions of ordinary least squares approaches. The Koyck procedure (use of a lagged autoregressive term) was used to handle the lagged effects of advertising.

The data base utilized is monthly-district data for FY80, yielding over five hundred "cells." The one year period was necessitated by the following data considerations:

- i) the detailed breakdown of NOIC leads by origination source was not available prior to FY80;
- ii) JADOR advertising by month by district, while available for FY80, was not available for FY81.

The variables included were: monthly seasonal variables; the district's key demographics consisting of the size of its male, High School senior population; the percent of the district's male, 17-21 year old population that is black; percent of the district's male, 17-21 year old population that is in a SMSA (this captures the so-called "urban-rural" character of the district); the district's local general unemployment rate; the district's Navy propensity (a response to a questionnaire and a proxy for education, tradition, proximity to military bases, etc.); the district's levels of advertising expenditures in the General Enlisted Program (GEP) - General TV/Radio campaign; GEP - General Magazine campaign; GEP - General Direct Mail campaign; GEP - Minority campaign; the JADOR TV/Radio campaign, the JADOR - Magazine campaign; and the JADOR Direct Mail campaign. The results are displayed in Table 2 and show a marked substitution effect of JADOR advertising on NOIC - Navy originated leads, i.e., instead of NOIC - Navy originated leads, one obtains NOIC - JADOR originated leads. The results also show the effect of HS seniors, unemployment rates, urban-rural character of district and propensity.

The key conclusion is that, in terms of strict NOIC - Navy lead production, at least for FY80, Direct Mail is the big winner. (This agrees with the philosophy that Navy's TV/Radio campaign is geared more to building awareness than leads per se.) The significant negative effect of JADOR advertising on NOIC - Navy originated

TABLE 2

## ESTIMATED ELASTICITIES FOR NOIC - NAVY ORIGINATED LEADS (FY80)

<u>Factor</u>	<u>Estimated Long Term Elasticity</u>
1) Size of Male High School Senior Population	1.004
2) Local Unemployment Rate	.1854
3) Percent of District's Male 17-21 Year Old Population that is Urban	1.025
4) Percent of District's Male 17-21 Year Old Population that is Black	Negative but statistically insignificant at the 10% level of significance
5) Propensity to Enlist	1.829
6) Navy's GEP - TV/Radio Expenditures	.016
7) Navy's GEP - General Magazine Expenditures	Insignificant due to extremely low level of expenditures in FY80.
8) Navy's GEP - General Direct Mail Expenditures	.305
9) Navy's Minority Expenditures	-.041
10) JADOR TV/Radio Expenditures	Negative but insignificant at 10% level
11) JADOR Magazine Expenditures	-.112
12) JADOR Direct Mail	-.239

leads could have been expected, on reflection, due to the above mentioned substitution phenomenon. Note that no synergistic or reinforcement effect of Joint Advertising on NOIC - Navy sourced leads was observed. We also note the negative sign for the percent of the district's male 17-21 year old population that is black, capturing the lack of propensity for blacks to the Navy. The insignificance of GEP - General Magazines is due to its extremely small levels, i.e., only \$38 thousand in FY80 and \$110 thousand in FY81. To help estimate the elasticity related to GEP - Magazines, a run was made for FY79 and FY80 on total NOIC leads and yielded an elasticity for GEP - General Magazines equal to about half of that obtained for GEP - General Direct Mail.

One value of Table 2 is that it provides useful information on the total minimum cost of increasing NOIC - Navy leads from the various sources. Using the so-called duality relationship associated with a generalized Cobb-Douglas production technology (e.g., see [2]), one can estimate a minimum cost function related to the production of NOIC - Navy leads. The result can be stated as follows:

The minimum total cost of producing a given number of NOIC - Navy leads, call it  $x$ , is a constant times  $x^{3.28}$ , thereby showing the strongly increasing margin cost of additional NOIC - Navy originated leads due to the fixed pool of eligibles. The constant is a function of demographics and will vary by year based on the unemployment rate, propensities, number of HS seniors, etc. To see the reasonableness of this, we observe that the highest elasticity of .305 related to the production of NOIC - Navy leads was for GEP - General Direct Mail. This implies that a 10% increase in the GEP Direct Mail budget would be accompanied by a 3.05% increase in NOIC - Navy originated leads. To see the cost implications of this, observe that GEP - Direct Mail expenditures were at the level of \$430 thousand for FY80. Hence another \$43 thousand in FY80 would be estimated to produce another 3.05% in NOIC - Navy leads or  $.0305(69,709) = 2,126$  leads. Hence, we have  $\$43 \text{ thousand} / 2,126 = \$20$  in additional placement costs for each additional NOIC - Navy lead or about \$26 including overhead. This is to be compared with an average of about \$8 per NOIC - Navy source lead from the direct mail campaign (i.e.,  $\$430K / 69,709 \times 1.28$ ).

In addition, the regression equation yielded an autoregressive coefficient of .365 from which it can be computed that it takes 3 months from the showing of Navy advertising for 95% of its total effect on the production of NOIC - Navy leads to be realized. This agrees very well with the Navy's planning factor.

## 2.2 Results for NOIC - JADOR Originated Leads

The previous results showed an intuitive negative effect on NOIC - Navy leads of JADOR advertising, due to the substitution effect. However, it will be shown JADOR does indeed have a positive impact on NOIC - JADOR originated leads. The results are for the same year, using the same estimation procedure.

Based on the autoregressive term, it takes 2.1 months for 95% of the impact of JADOR advertising to make itself felt on NOIC - JADOR originated leads. The implication of this is that JADOR advertising dissipates at a faster rate than does the Navy specific advertising. From Table 3, we see the expected effects of JADOR advertising on NOIC - JADOR leads. We observe that JADOR magazines appear to be particularly effective (as would no doubt Navy - Magazine advertising had it been at non-trivial levels) with an elasticity of .192. We see that the JADOR Direct Mail does not appear as effective as does Navy Direct Mail in producing NOIC leads, perhaps since it produces leads for the other Services as well. We also note the small but statistically significant and possible synergistic effect of Navy Direct Mail on NOIC - JADOR leads. Perhaps the reinforcement of Navy's Direct Mail enhances the impact of the JADOR Direct Mail campaign. The other possible explanation is that the pulsing of the two direct mail programs over time are highly related and that the regression cannot separate out the individual effects due to collinearity.

Appealing to the same duality theory as was done for NOIC - Navy leads, yields the following functional relationship between a total of  $x$  NOIC - JADOR leads and the minimum cost required: the cost function can be expressed as a constant times  $x^{3.614}$ .

TABLE 3  
ESTIMATED LONG TERM ELASTICITIES FOR NOIC - JADOR LEADS

<u>Factor</u>	<u>Estimated Long Term Elasticity</u>
1) Size of Male High School Senior Population	.446
2) Local Unemployment Rate	.138
3) Percent of District's Male 17-21 Year Old Population that is Urban	.663
4) Percent of District's Male 17-21 Year Old Population that is Black	Positive but insignificant at 10% level of significance.
5) Navy Propensity to Enlist	Positive but insignificant at 10% level (significant at 13% level)
6) Navy GEP - General TV/Radio	Positive but insignificant
7) Navy GEP - Magazine	Positive but insignificant (due to very small magazine level in FY80)
8) Navy GEP Direct Mail Expenditures	.029
9) Navy Minority Expenditures	Negative but insignificant at 10% level
10) JADOR TV/Radio Expenditures	.067
11) JADOR Magazine Expenditures	.192
12) JADOR Direct Mail Expenditures	.078

This is to be compared with the analogous exponent of 3.38 for Navy specific advertising on NOIC - Navy leads. If one further then examines the marginal cost-effectiveness of the best of JADOR media for producing NOIC - JADOR leads i.e., the media of JADOR Magazines with an elasticity of .19, one finds a marginal placement cost per additional NOIC - JADOR source lead of about \$152. This is to be compared with \$20 for more production of NOIC - Navy leads than more GEP - General Mail. However, the strong caveat is that JADOR advertising of course also produces leads for other services which is ignored in these calculations.

### 2.3 Results for Total NOIC Leads, Regardless of Origin

The Navy of course is interested in total NOIC leads, regardless of their origin. To gain some insights into this, a 2-year run was performed for FY79 and FY80. The advertising expenditures were adjusted to reflect a constant purchasing power over the 24 month period. This time period is a more attractive one for analysis than is FY80 alone since Navy GEP - General Magazine advertising was at reasonably high levels in FY79, i.e., \$525 thousand compared to \$38 thousand in FY80 and \$110K in FY81. The results show that, on balance, JADOR Mail and possibly JADOR TV/Radio while they certainly produce NOIC - JADOR leads, may actually lower the total production of NOIC leads. One possible explanation is that the JADOR Mail could be siphoning some of the leads to the other Services that would have naturally come to the Navy, had Navy specific advertising been operating alone. It also shows the strong impact of Navy Magazine advertising on NOIC contracts, a result not available from FY80 alone since Navy Magazine advertising was miniscule in FY80.

The results indicate that, if the Navy is interested in maximizing the total number of NOIC leads, but retains no control over the levels and mix of the JADOR advertising levels, that the ratio of GEP - Magazine advertising to the total of GEP - General Magazine and GEP - General Direct Mail should be about one third. For FY80, we have remarked that GEP - General Magazines was regrettably much too low. In FY81, the mix was closer to the ideal, where magazine advertising was at

\$110 thousand and direct mail was at \$258 thousand. This ratio of one third should be viewed as a lower bound since magazine advertising may actually have an impact on generating quality contracts, over and above its effect on generating leads. See [3] for analysis of so-called "walk-in" leads. Table 4 is presented to summarize the findings for NOIC leads.

#### 2.4 Local Leads

The analysis of local leads (i.e., the outputs of the LAMS program) is difficult due to: i) the newness of the program, i.e., formal collection of the data began in FY80; ii) the incompleteness of the data, i.e., several districts reported no local leads which may well be a reporting artifact; iii) the local leads were collected only quarterly for FY80 but monthly for FY81; and iv) LAMS dollars of advertising have only reported quarterly.

With these limitations and not wanting to risk prorating the quarterly LAMS dollars to a monthly level, a regression run was made using quarterly district data for FY80 and FY81. The dependent or predictive variable was the number of qualified local leads deemed "interested." That is, at the time of the inquiry by the potential recruit he is informed, particularly if he responded to a "blind" ad, that the Navy is the prospective employer; an "interested" lead is one who still wants more information, in spite of learning this.

In this analysis any districts reporting 0 local leads for any quarter were dropped as it was feared that they may have represented reporting inadequacies rather than the true state of affairs; this resulted in 4 districts being dropped. The independent variables included were the quarterly LAMS dollars (adjusted for inflation), quarterly seasonal variables, the local unemployment rate, the percent of the district's male 17-21 year old population that was black, and the percent of the district's male, 17-21 year old population considered to be "urban," i.e., in a SMSA.

The results yielded a point estimate of the elasticity for LAMS advertising on local leads of .53, down somewhat from the .889 elasticity estimated using FY80 data only (with the districts reporting zero levels included). However, even taking

TABLE 4

COMPARISON OF ELASTICITIES FOR NOIC - NAVY LEADS,  
NOIC - JADOR LEADS, AND TOTAL NOIC LEADS (long term elasticities)

<u>Factor</u>	<u>NOIC - Navy (FY80 only)</u>	<u>NOIC - JADOR (FY80 only)</u>	<u>All NOIC Leads (FY79, 80)</u>
1) High School Senior Male Population	1.004	.446	.64
2) Local General Unemployment Rate	.1854	.138	.241
3) Percent of District's Male 17-21 Year Old Population that is Urban	1.025	.663	.183
4) Percent of District's Male 17-21 Year Old Population that is Black	Insignificant	Insignificant	.149
5) Propensity (Proxy for military tradition in area, proximity to military bases, etc.)	1.829	Positive but insignificant at level of 13%	.516
6) Navy GEP - General TV/Radio Expenditures	.016	Positive but insignificant	.0243
7) Navy GEP - General Magazine	Insignificant because of extremely low level of magazines expenditures	Positive but insignificant	.0841 (2 years are included with heat Navy magazine advertising in FY7
8) Navy GEP - General Direct Mail	.305	.029	.1746
9) Navy Minority Campaign	-.041	Negative but insignificant	Insignificant
10) JADOR TV/Radio	Negative but insignificant	.067	-.009
11) JADOR Magazine	-.112 (substitution effect) where one trades off NOIC-JADOR leads for Navy - NOIC leads	.192	.0413
12) JADOR Direct Mail	-.239 (same substitution effect)	.078	-.0349



the .53 estimate, the 90,624 "interested" qualified local leads obtained in FY82 for the \$1.325 million spent, and an elasticity of .53, imply that the marginal placement cost per additional interested/qualified local lead would be about \$28, and \$38 with a 38% overhead factor included. The other variables with intuitive but insignificant elasticities were: unemployment rate at .95, percent black at .14, and percent urban at -.53. The duality cost relationship yields an exponent for the minimum cost to produce x local leads of 1.89.

The fact that local leads and LAMS advertising expenditures were collected in FY82 at the monthly level will be very helpful in estimating lag effects for local leads. It is also recommended that the Navy undertake efforts to resolve the interpretation of 0's in the lead data bases, i.e., are they truly 0's or a problem in reporting.

It might be mentioned in passing that excursions on the above model dealing with the possible impact of the national Navy campaigns on the production of interested qualified local leads (the hypothesis being that the national campaign might sway a qualified respondent to a blind ad to be more open to the Navy as an employer) were not able to discern any impact.

Table 5 summarizes some of the key information for the various types of leads.

## 2.5 Upper Mental, HSDG Contracts as a Function of Demographics, Recruiters and Various Types of Leads

Of course, the bottom line for the three different types of leads is how they impact on enlistments, particularly quality enlistments, since the numbers associated with lower quality enlistments represent more of a demand limitation rather than a true supply consideration.

The time period studied is FY81 since for FY81, monthly district local leads were available, together with broken out NOIC leads. The results from a monthly-district regression model, with Upper Mental HSDG contracts as the dependent variable and the various types of leads, recruiters and demographics as the independent variables, follows. Differences in the imposed lag structure for local leads from NOIC leads was permitted.

An inspection of Table 6 shows NOIC Navy specific leads as having almost a 50%

TABLE 5  
LEAD COMPARISON SUMMARY

	<u>Local Leads</u>	<u>NOIC - Navy Originated</u>	<u>NOIC-JADOR Originated</u>
1) Number in FY80	55,645	69,709	76,756
2) Number in FY81	61,477	136,832	85,911
3) Number in FY82	90,624	141,753	71,499
4) Average Cost in FY80 * (including overhead)	\$30	\$67	\$128
5) Average Cost in FY81 * (including overhead)	\$32	\$60	\$119
6) Average Cost in FY82 * (including overhead)	\$21	\$67	?
7) Lowest Marginal Cost in FY81 (including overhead) per additional lead if additional resources put into most cost-effective media	\$57	\$26	\$195
8) Most Important Media Type	LAMS (elasticity of .53)	Navy-Direct Mail (elasticity of .305)	JADOR Maga- zines (elasticity of .192)
9) The Minimum Total Cost to Produce X Leads of Each Type is a Constant Times:	X <sup>1.89</sup>	X <sup>3.28</sup>	X <sup>3.614</sup>
10) The Lag Period Involved so that 95% of Advertising Impact is Felt	Less than 1 month	3 months	2.1 months
11) Marginal Yield Rate for Upper Mental HSDG Contracts in FY80	.56%	4.05%	2.52%
12) Marginal Yield Rate for Upper Mental HSDG Contracts in FY81	.49%	2.02%	2.2%
13) Marginal Yield Rate for Upper Mental HSDG Contracts in FY82	.39%	2.26%	1.55%

\* The overhead rates used, based on FY80 expenses, were 28% for Navy national advertising and 38% for the LAMS program; the 28% rate was also used to estimate the JADOR overhead rate.

N.A. - Not Available

TABLE 6  
ELASTICITIES FOR UPPER MENTAL HSDG CONTRACTS OF RECRUITERS,  
VARIOUS TYPES OF LEADS AND DEMOGRAPHICS

<u>Factor</u>	<u>Elasticity</u>	<u>T-Value</u>
1) Number of Upper Mental HS Male Seniors in District	.393	7.100
2) Local General Unemployment Rate	.14	3.49
3) Percent of District's Population that is Urban	-.327	7.28
4) Propensity to Enlist	Insignificant (propensity is not a factor due to fact that leads of various types are included and they capture propensity)	1.67 (not significant at 5% level)
5) Ratio of Military Pay to Civilian Pay	.64	3.12
6) Number of Production Recruiters in District	.562	10.4
7) Number of Interested Qualified Local Leads with 1 Month Lag	.008	1.97
8) Number of Navy Originated NOIC Leads (2 month lag)	.073	8.17
9) Number of JADOR Originated NOIC Leads (2 month lag)	.050	4.57

higher elasticity on Upper Mental HSDG contracts than is the case for NOIC - JADOR leads where the individual may be a lead for several of the Services. The relative elasticities are .073 for NOIC - Navy leads compared to .05 for NOIC - JADOR leads. These results imply for FY82 a marginal yield rate of 2.26¢ for all NOIC - Navy specific leads to Upper Mental, HSDG contracts and 1.58% for NOIC - JADOR leads. This follows since in FY82, there were a total of 43,863 Upper Mental, HSDG contracts with 141,753 NOIC - Navy leads. Hence another 1% of NOIC - Navy leads (i.e., 1,418 NOIC - Navy leads) would yield an estimated 32.02 Upper Mental, HSDG contracts (i.e.,  $.00073 \times 43,863$ ). Hence the ratio of 31.02 to 1,418 or 2.26% is the marginal yield rate. These are lower than the 3.7% conversion rate espoused by Navy for all NOIC leads since it is at the margin, and since the Navy's conversion factor is for all contracts, not just Upper Mental, HSDG contracts.

In addition the elasticity for local leads on Upper Mental, HSDG contracts from FY81 is at .008 and is about half of that found if the dependent variable is HSG contracts. Hence, the marginal yield rate from local leads relative to all contracts is quite high (i.e., 4.4% for FY81). This is intuitive to this investigator since he would think many respondents to LAMS advertising may not be Upper Mental, HSDG qualified. A very useful piece of data for the future would be the number of NOIC leads and local leads that re HSDG or Upper Mental HSDG qualified. This type of information is presently being collected for JADOR - sourced leads [see Brandewie, DMDC].

## 2.6 Aggregated Impacts for Upper Mental, HSDG Contracts of Demographics and Various Types of Resources

Section 2.6 provides a mechanism to compute the net effects on Upper Mental, HSDG male contract production, of various types of resources by substituting, in place of each of the three types of leads, the three earlier derived equations. This algebraic substitution enables us to estimate separate elasticities for each of the resources utilized while avoiding much of the collinearity problems present had we attempted to estimate the effects of advertising directly on Upper Mental, HSDG contracts. The results can be found in Table 7. The implications of Table 7 are discussed in 3.0. Note that the resources having the largest impacts are recruiters and Navy's GEP -

TABLE 7

ESTIMATED AGGREGATED IMPACTS OF RESOURCES ON UPPER MENTAL, HSDG CONTRACTS  
(Based on FY80 and FY81)

<u>Factor</u>	<u>Long Term Overall Elasticity</u>	<u>Sources of Impacts</u>
1) Number of Upper Mental HS Seniors	.393	Directly impacts on Upper Mental HSDG Contracts.
2) Number of Male HS Seniors	.095	Affects each of three types of leads.
3) Local Unemployment Rate	.168	Affects production of each of three types of leads and also directly impacts Upper Mental, HSDG contracts.
4) Navy Propensity	.134	Affects NOIC - Navy leads.
5) Percent of District's Population that is Characterized as Urban	-.219	Production of NOIC leads of both types positively effected by urban-rural mix, but direct effect on Upper Mental, HSDG contracts is negative.
6) Level of First Year Military Pay to Civilian Pay	.64	Impacts directly on Upper Mental HSDG contracts.
7) Number of Production Recruiters	.562	Impacts directly on Upper Mental HSDG Contracts
8) LAMS Advertising	.00424	Affects on production of local lead The elasticity is product of .53 (LAMS elasticity on local leads) and .008 (elasticity of local leads on Upper Mental, HSDG contracts).
9) GEP - General TV/Radio	.0012	Impacts through NOIC - Navy leads.
10) GEP - General Magazines	0 (resource at too small of level in FY80 or 81 to be significant)	Should impact NOIC - Navy leads and perhaps on "walk-ins."
11) GEP - General Direct Mail	.0238	Appears to help production of both types of NOIC leads.
12) GEP - Minority Advertising	-.0030	Small negative impact on NOIC - Navy leads.
13) JADOR TV/Radio	.0034	Impacts NOIC - JADOR sourced leads.
14) JADOR Magazines	.0014	Negative substitution effect on NOI Navy sourced leads but strong positive effect on NOIC - JADOR sourced leads for net positive effect.
15) JADOR Direct Mail	-.0135	Positive effect on NOIC - JADOR sourced leads but strong negative effect on NOIC - Navy leads for net negative effect.

Direct Mail.

### 3.0 THE OPTIMAL SHARES OF EACH RESOURCE IMPLIED BY ECONOMETRIC ANALYSES

Consider the following optimization problem. Determine levels of  $X_1, X_2, \dots, X_N$ , so that:

$$y \geq A X_1^{\alpha_1} X_2^{\alpha_2} \dots X_N^{\alpha_N}, \text{ and so as to}$$

$$\text{Minimize: } C_1 X_1 + C_2 X_2 + \dots, C_N X_N$$

(The interpretation in our setting is that the  $y$  represents the number of Upper Mental, HSDG contracts required in a given year, the  $X_1, \dots, X_N$  are the levels of different types of resources available, e.g., local advertising, recruiters, GEP - General TV/Radio, etc. (measured in recruiting man-months or placement costs of various advertising) and the  $C_i$ 's are the total cost per unit of the  $i^{\text{th}}$  resource, i.e., cost per man-month of recruiter effort, total cost associated with each place dollar of advertising, including overhead and profit, etc. Then the Recruiting Command's problem is to select the mix of resources to minimize the total cost involved, and yet meet the required level of new HSG contracts. (Note that the constant  $A$  captures the demographics and variables over which the Navy has no control.)

Then using the so-called duality relationship (see 2, it can be shown that; the total minimum cost required to meet the level of output  $y$  (i.e., the number of Upper Mental, HSDG contracts in a given year) is given by a constant times

$$\prod_{i=1}^N C_i^{\frac{\alpha_i}{N}} y^{\frac{1}{N}} \quad (1)$$

Hence since  $\sum \alpha_j = .58$ , we find the optimal minimum cost to produce a total of  $y$  Upper Mental HSDG contracts is a function of  $y$  raised to the 1.72 power. Hence the long term average minimum cost per HSG contract increases approximately as a function of  $y^{.72}$ , and shows the diminishing return nature of recruiting resources. Further the optimal ratio of say  $X_1$  to  $X_2$  is given by:

$$\frac{\alpha_1 C_2}{\alpha_2 C_1} = \frac{X_1^*}{X_2^*} \text{ or } \frac{C_1 X_1^*}{C_2 X_2^*} = \frac{\alpha_1}{\alpha_2} \quad (2)$$

where the asterick denotes the optimal levels. To illustrate the use of (2), con-

sider the optimal ratio of all Navy specific advertising expenditures (excluding Minority advertising since it's level is dictated by other than economic considerations) to recruiter-related expenditures. Then the sum of all the Navy advertising elasticities are .00424 (for LAMS) plus .0012 (for Navy TV/Radio) + .0238 (for Navy Direct Mail) = .0292.\* The corresponding elasticity for production recruiters is .562. Hence if  $C_2$  represents the cost per man year for a recruiter (including his support costs, fringes, etc.), and if  $C_1$  represents the completely loaded costs for each \$1 of placement cost in Navy advertising, then the right hand side of (2) is the optimal ratio of these two resource shares.

Since we don't have agreement on  $C_2$  or  $C_1$ , consider what the actual experience would impute for FY81 (in terms of the ratio of  $C_2/C_1$ ) if indeed these two resources were properly balanced in FY81. In FY81, the total of GEP - General and LAMS Advertising was \$7.263 million; there were also consumed a total of 3,793.4 man-years of recruiter effort. Hence  $X_1/X_2$ , for FY81, was in fact \$7.263M/3,793.4 man-years = \$1,914 of Navy advertising/recruiter man-year. Hence we have:

$$\frac{X_1^*}{X_2^*} = \frac{\alpha_1 \hat{C}_2}{\alpha_2 \hat{C}_1} = 1,914 \quad (3)$$

where  $\hat{C}_1$  represents the estimated imputed loading factor for Navy specific advertising and  $\hat{C}_2$  the estimated imputed man-year cost for a recruiter, implied by the actual experience in FY81.

But since  $\alpha_1 = .0292$ , and  $\alpha_2 = .562$ , one obtains from (3) that

$$\frac{\hat{C}_2}{\hat{C}_1} = 36,837 \quad (4)$$

i.e., the implied ratio of the total cost per man-year for a recruiter to the factor that multiplies placement cost for Navy advertising would be 36,837. To see if this is in the ballpark, observe that if an overhead factor of 26% were applied for GEP -

\* This ignores the impact of magazine advertising which could not be measured due to the low levels utilized in FY80 and FY81.

General Navy advertising in FY80 and a factor of 38% is applied for AMS advertising, then a dollar weighted estimate of  $C_1$  for FY81 would be:

$$C_1 = 1.26 \times \$5.85M/\$7.263M + 1.38 \times 1.494M/\$7.263M = 1.283$$

This implies that if a recruiter man year, fully loaded, were about \$47K in FY81, then the ideal ratio in (4) would result. In other words, for FY81, if the advertising overhead factors and recruiter man-year costs (including support, benefits, non-production recruiters, headquarters, etc.) were approximately equal to the above state values, then the recruiter and Navy specific advertising expenditures would have been properly balanced in terms of obtaining the most Upper Mental, HSDG male contracts for a given budget. The caveat to the above is that GEP - General Magazine does probably have a significant effect (even though it couldn't be estimated using FY80 or FY81 data due to the low levels) with the result that the optimal proportion of Navy advertising is probably somewhat understated. In summary then, to the extent that the cost of a recruiter (fully loaded), was less than \$47K in 1981, the recruiters were underfunded in terms of the output of Upper Mental, HSDG contracts.

Consider next the mix of LAMS (local advertising) versus Navy GEP - General. In this case,  $\alpha_{LAMS} = .00424$  (for LAMS) and the Navy GEP - General elasticity (excluding magazines since its effects couldn't be estimated) would be .0250. Hence the estimated optimal mix between these two classes of resources, in terms of maximizing Upper Mental, HSDG contracts, would be given by the ratio of the two burdened costs:

$$\frac{C_{LAMS} X_{LAMS}}{C_{GEP} X_{GEP}} = \frac{.00424}{.0250} = .16 \quad (4)$$

Considering the actual mix for FY81, we see that  $X_{LAMS}$  was \$1.404 million in placement cost versus \$5.859 million for GEP - General placement costs. In addition, estimating the overhead factor for GEP - General at 26% and the overhead factor for LAMS at 38%, we arrive at an actual ratio for (4) of  $\$1.404 \text{ million} \times 1.38 / \$5.859 \times 1.26 = .262$ , implying that for FY81, the LAMS portion of advertising was apparently slightly overfunded in terms solely of the production of Upper Mental, HSDG contracts. Of course, this is not the only goal and LAMS has been found to be very effective in obtaining HSG (i.e., especially GED;s) contracts and Lower Mental, HSDG contracts.



Hence a larger role for LAMS can be justified.

In summary, the aggregated results of Table 7, combined with the use of the Dorfman-Steiner Theorem (i.e., the ratio of elasticities), can be very helpful to the Navy in arriving at the best mix of their resources. The same approach has real possibility for aiding in determining the relative mix of JADOR versus service specific advertising, especially if one could perform the types of analysis represented in this report for the Air Force, Army and Marine Corps. Armed with the separate impacts of JADOR advertising versus each of the Services' own advertising campaigns, together with the contract quotas for each of the Services and demographic scenarios, one could determine the best mix of JADOR versus all Service specific advertising levels to insure the various contract quotas are met at minimum total advertising costs.

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<p>An approach for determining the optimal resource mix is also provided.</p>		

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